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ON-FARM DRYING AND STORAGE COSTS FOR CORN, ONTARIO, 1978 AND 1979

BY

G. A. FISHER

ECONOMICS BRANCH

ONTARIO MINISTRY OF AGRICULTURE AND FOOD
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INTRODUCTION

In the early 1960s, Ontario farmers began to switch from ear-picking to field-shelling of corn. This harvesting change resulted in a new approach to corn handling and marketing. In many areas, country elevators could not cope with the rapidly increasing deliveries of high-moisture shelled corn. Discouraged by long delivery line-ups as well as lost harvest time, farmers began purchasing their own drying and storage facilities. The continued expansion of corn production across the province has encouraged an increasing number of new growers to consider installing on-farm drying and storage systems. At present, however, high interest rates are causing many producers concern about the costs of purchasing such facilities and of storing corn on the farm.

In 1978, the Ontario Ministry of Agriculture and Food initiated a study of on-farm corn drying and storage systems. Because of the unusually good drying and harvesting conditions for corn across Ontario in 1978, the drying portion of the study was continued in 1979. The main objectives of the study were:

1. To determine costs for drying and storing corn at the farm; and

2. To provide comparisons of costs between 1978 and 1979 for all growers in the study and for those growers who participated in the study in both years.

The present report is intended to complement an earlier document on on-farm corn drying and storage.[1] The latter provided information on costs for a number of growers in the corn-producing areas of Ontario. As well, it included data in budget form on drying and storage costs for different annual volumes of production, and other information intended to assist farmers in calculating annual costs for existing or proposed drying and storage systems.

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[1] G.A. Fisher, *On-Farm Drying and Storage Costs for Corn, Ontario, 1978* (Toronto: Economics Branch, Ontario Ministry of Agriculture and Food, February 1980).

SUMMARY

In the early 1960s, Ontario farmers began to switch from ear-picking to field-shelling of corn. Many factors can influence the choice of equipment for drying and storing corn, but a comparison of costs of existing systems can aid in making the final decision. This report gives the results of annual costs for operating the three major drying systems available (in-bin, batch, and continuous flow) on 58 Ontario farms in 1978 and 38 in 1979.

TRENDS IN ONTARIO CORN PRODUCTION

From 1961 to 1980, Ontario grain corn area has expanded five-fold, from 160 000 to 809 000 hectares, to produce 4.7 million tonnes in 1980. At present, less than 1 percent of the corn crop is harvested and stored as ear corn; 15 percent is harvested and stored at the farm as high-moisture corn; and the remaining 84 percent is harvested as shelled corn, which must be dried either at the farm or at the commercial elevator to ensure safe storage.

COSTS OF ON-FARM DRYING

The total operating costs of drying (fuel, electricity, and labor), expressed as a percentage of total drying costs, varied in 1978 from 38 percent for batch dryers to 50 percent for in-bin and 42 percent for continuous-flow dryers. In 1979, the percentages of operating costs were 45 percent for batch, 49 percent for in-bin, and 57 percent for continuous-flow dryers. The remaining portion of total drying costs was made up of fixed costs, which included depreciation, interest, insurance, taxes, and repairs and maintenance.

Steadily increasing energy costs, combined with varying levels of moisture content from year to year, make fuel a major cost item in the artificial drying of corn. The high average moisture content of corn in 1979 required each system under study to consume more propane than had been used in 1978 to dry a tonne of corn to the same level of 15.5 percent moisture. For the group of growers who cooperated in both years of the study, the average beginning moisture content in 1979 was 30.8 percent and required 41 litres of propane to dry one tonne of corn to 15.5 percent moisture. In comparison, with an average beginning moisture content of 26.5 percent in 1978, the same growers used 29 litres of propane, or 29 percent less.

ON-FARM AS COMPARED WITH COMMERCIAL DRYING COSTS

The drying costs calculated for the three on-farm systems using propane in 1979 (in-bin, $8.81 per tonne; batch, $9.72; and continuous flow, $8.45) compare very favorably with the charge of $13.10 per tonne (using propane with moisture at 30.8 percent) published by the Ontario Grain and Feed Dealers' Association, September 1, 1980.

ON-FARM STORAGE COSTS

The average annual on-farm storage costs for all storage systems amounted to $2.25 per tonne in 1978 and $2.12 in 1979. For each grower, storage costs per tonne depended on the age of the storage structure, the type of structure, and its annual use.

ON-FARM AS COMPARED WITH COMMERCIAL STORAGE COSTS

The average annual on-farm storage cost for existing facilities was equal to about three months of commercial storage charges.

PRINCIPAL COST CONSIDERATIONS

It costs money to store corn either at the farm or at the country elevator. At both locations, drying, handling, and transportation costs are incurred before the corn is in storage. Other costs to be considered are interest on the value of the stored corn, shrinkage, and invisible loss. These costs will vary for individual producers.

The decision to store corn on the farm is influenced by the grower's expectation of higher prices in future months, as well as current interest rates. Interest costs can be an expense of storage in two ways. If the grower stores his crop instead of selling it at harvest, he may have to carry the interest charges on operating loans that could otherwise be paid off. In addition, there is interest on the value of the stored corn resulting from the lost opportunity to invest the proceeds that would be obtained from sale of the crop.

TRENDS IN ONTARIO CORN PRODUCTION

The expansion of grain corn area combined with larger yields per hectare brought Ontario production to over 4.7 million tonnes in 1980 (Table 1). Between 1961 and 1980, grain corn area increased five-fold, from 160 000 to 809 000 hectares. It is unlikely that this rate of increase will be maintained over the next 20 years, mainly because of the shortage of suitable land for corn production, environmental problems, and competition from other crops and non-agricultural uses. The expansion of grain corn as a percentage of area in major crops is continuing in all regions of the province.

Yields per hectare have risen at a steady rate over the 20-year period 1961-1980. The five-year average yields for Ontario corn production have increased by over 17 percent, from 4.77 to 5.60 tonnes per hectare, during the same period.

Farm value per hectare amounted to $244 for the period 1961-65. This value has increased by two and one-half times to $607 per hectare for the five-year period 1976-80.

Table 1.—Grain Corn Area, Production, and Farm Value, Ontario, 1961-1980

Year	Area	Production, t		Farm value, $	
		Total	Per ha	Total	Per ha
	ha	'000		'000	
1961	160 000	739	4.62	35,200	220
1962	176 000	845	4.80	42,600	242
1963	222 000	915	4.12	49,300	222
1964	263 000	1339	5.09	68,500	260
1965	299 000	1508	5.04	77,200	258
1966	318 000	1646	5.18	95,200	299
1967	344 000	1835	5.33	90,300	262
1968	374 000	1995	5.33	97,400	260
1969	376 000	1774	4.72	91,500	243
1970	445 000	2375	5.34	127,200	286
1971	511 000	2599	5.09	117,600	230
1972	494 000	2355	4.77	151,100	306
1973	490 000	2643	5.39	263,300	537
1974	542 000	2383	4.40	284,200	524
1975	575 000	3318	5.77	329,200	573
1976	639 000	3427	5.36	296,300	464
1977	652 000	3867	5.93	328,800	504
1978	680 000	3488	5.13	358,200	527
1979	757 000	4298	5.68	494,370	653
1980	809 000	4710	5.82	668,837	827
5-year average					
1961-65	224 000	1069	4.77	54,560	244
1966-70	371 400	1925	5.18	100,320	270
1971-75	522 400	2660	5.09	229,080	439
1976-80	707 400	3958	5.60	429,301	607

Source: Ontario, *Agricultural Statistics for Ontario*, Publication 20 (Toronto: Ontario Ministry of Agriculture and Food, various years).

In Ontario, the combine has almost entirely replaced the corn picker for harvesting the crop. About 1 percent of the corn crop is harvested as ear corn. This method of harvest is largely concentrated in the south-western area of the province. Fifteen percent of Ontario's corn is harvested and stored at the farm as high-moisture corn, with the remaining 84 percent being harvested and stored as dry-shelled corn. All of this shelled corn must be dried by either on-farm or commercial dryers.

With today's equipment, corn can be harvested at varying degrees of moisture content and delivered to the farmyard as ear (whole or ground) or shelled corn. It may be stored whole on the ear, or in high-moisture shelled, ground ear, or dry shelled form.

Many livestock farmers in Ontario store high-moisture shelled corn in tower silos of open-topped concrete construction or oxygen-limiting design in concrete or steel. This storage method has three main advantages:

1. The grain requires little attention after being put into storage;

2. The grain can be used as high-quality livestock feed; and

3. The harvesting rate is not limited by the capacity of on-farm drying units.

There are, however, two disadvantages as well:

1. The grain can be used only as a livestock feed; and

2. In sealed storage units, spoilage may occur, either through faulty construction or because of poor management by the farmer.

ALTERNATIVE ON-FARM DRYING SYSTEMS

Three basic systems are commonly used for drying corn on the farm: in-bin, batch, and continuous-flow dryers. In recent years, some Ontario farms have made use of a fourth method, low-temperature drying. In this study, four growers supplied data on low-temperature drying for the 1978 season only. Information about the costs associated with this method appears in the report referred to earlier.[1]

Excepting the low-temperature method, the drying systems studied in 1978 and 1979 can be simply described as follows:

1. In-bin dryers. The in-bin systems studied were of two main types: one automatically removes a layer of dried grain from the bottom of the drying bin and transfers it either to the top of the same bin or to another bin; the other dries a quantity of corn in the bin as a batch, then releases the batch into the lower part of the drying bin or removes it entirely to another bin for storage.

2. Batch dryers. The batch dryers studied consist of separate drying units, which are either portable or stationary. On many farms, the batch dryer occupies a permanent position within the farm drying and storage system.

There are two types of batch dryers — the stationary and the recirculating types. In the stationary type, the grain is kept in one position during the entire drying period. This results in overdried grain being located near the hot air and underdried grain being located on the outside of the batch. As the grain is unloaded, a satisfactorily dried product can result if correct drying temperatures have been used. In comparison, the grain in recirculating batch dryers is constantly being mixed during the entire drying period. This system produces uniformly dried grain.

3. Continuous-flow dryers. All dryers of this type allow corn to flow continuously through the dryer. The grain enters wet at the top and is discharged dry and cool from the lower section.

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[1] Fisher, *op. cit.*

Information on corn-drying costs for 1978 and 1979 was gathered from 58 growers in 1978 and 38 growers in 1979. Of the 58 drying systems studied in 1978, 24 were in-bin, 22 were continuous-flow, and 8 were batch dryers (as mentioned already, the remaining four were low-temperature systems). For 1979, 19 were in-bin dryers, 14 were continuous-flow, and 5 were of the batch type. All were propane fueled, except for 6 in-bin systems that used natural gas.

There were 37 growers who cooperated in the study in both 1978 and 1979. In this group, 13 used in-bin, propane-fueled systems; 5 in-bin, natural-gas fueled; 5 batch, propane-fueled; and 14 continuous-flow, propane-fueled.

STUDY METHOD: DETERMINATION OF COSTS

The growers participating in the study were given forms on which to record operations performed, machinery and materials used, and any other cost items associated with drying and handling their corn crop in 1978 and 1979. Storage building costs were collected in 1978 and were used to calculate storage costs for 1979. Each grower provided information on the capacity of his drying and storage system, based on the maximum annual volume of corn and other grains handled by the system. The actual volume of harvested corn handled by the system in both years also was recorded.

Total drying and storage costs were obtained by adding reported operating and fixed costs. The specific items included in each of these two categories are identified and explained below. Costs not recorded in this study were the opportunity interest cost represented by the return the producer could obtain by selling his corn crop at harvest and investing the proceeds; the costs of overdrying; and invisible loss.[1] As well, no costs were included for harvesting and hauling shelled corn to the dryer.

ANNUAL FIXED COSTS

Growers supplied information on costs for all dryers, storage bins, tractors, and other equipment at the time of purchase. Fixed costs related to these components of the system were broken down into five subcategories: interest, depreciation, insurance, taxes, and repairs and maintenance.

Interest. Interest on investment was calculated at 9 percent, which was the Farm Credit Corporation lending rate under the Farm Syndicate Credit Act in the spring of 1978. The total investment in each on-farm

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[1] Invisible loss is discussed later in this report (p. 18).

drying and storage system was calculated at an interest rate of 4.5 percent. This assumes that over the lifetime of the system, an average value equal to one-half of the purchase cost has been used.

Depreciation. Depreciation costs were calculated as follows:

Type of asset	*Depreciation as a % of purchase cost*
Steel structures	5.0
Concrete structures	2.5
Unloading pits, platforms, scales, and other concrete structures	2.5
Wooden storage structures	5.0
Dryers, augers, legs, moisture meters, grain spreaders, electrical hook-ups	10.0

Insurance. Each grower was asked to provide cost information on all insurance coverage for dryers, storage buildings, other equipment, and produce.

Taxes. Real estate taxes on buildings only were calculated at a cost equal to one-tenth of 1 percent times the building investment.

Repairs and maintenance. As few growers were able to supply detailed information about the repair and maintenance costs associated with their drying and storage equipment, a standard method of calculating these costs was used. The following percentages were assigned:

Type of machine or structure	*Repairs & maintenance as a % of purchase cost*
Steel structures:	
20 years & under	1.0
Over 20 years	3.0
Concrete structures, scales, unloading pits and platforms, other concrete structures	.25
Dryers, augers, legs, moisture meters, grain cleaners, electrical grain spreaders, electrical hook-ups:	
10 years and under	4.0
Over 10 years	6.0

ANNUAL OPERATING COSTS

In this study, annual operating costs consisted of the costs of drying fuel, electricity, and labor.

Fuel. Each grower supplied information on type of fuel used, amount used, and cost. In most cases, the average moisture content of the corn dried also was reported.

Electricity. Each grower indicated the cost of electricity used during the drying and aeration periods. Some farmers had to make estimates, as there was not a separate meter for the dryer and storage system.

Labor. Growers recorded labor hours for all unpaid family members and for all hired help used during drying and post-drying operations.

A standard rate — $4 per hour in 1978 and $4.50 in 1979 — was used to determine the labor cost for the operator and unpaid family workers. The wage rates for hired labor were the amounts actually paid and included all applicable employee benefits.

COMPARISON OF DRYING AND STORAGE COSTS FOR DIFFERENT DRYING SYSTEMS, ALL GROWERS STUDIED

FIXED COSTS

Fixed costs for each grower depended on the type, age, and annual use of the dryer and storage bins. Because of the variation in capital investment according to year of purchase, relatively low annual fixed costs did not necessarily reflect a relatively high volume of use. Also, differences in storage costs were not related to the type of drying system used.

The use of drying systems was higher in 1979 than in the previous year; accordingly, fixed costs per tonne of corn dried decreased for each system under study (Table 2). In both years, the average use of continuous-flow dryers was greater than that of the other two systems. For all dryers, the average annual use for all grains was 1555 tonnes or an increase of 16 percent over the 1338 tonnes dried in 1978; in the case of corn, 28 percent more was dried in 1979 than in 1978. This increase occurred as a result of increases in both area and yield in 1979 over 1978 for the average of all growers.

In 1978, fixed costs made up 56 percent of total drying costs for batch dryers and 45 percent for both in-bin and continuous-flow dryers. Increased use in 1979 brought about a reduction in the fixed portion of total drying costs, to 45 percent for batch dryers and 37 percent and 31 percent, respectively, for in-bin and continuous-flow dryers.

The total fixed costs of drying and storage for each system were lower in 1979 than in 1978, as a result of increased volumes of grain handled (Table 3). The average fixed costs for the two years varied from a low of $2.61 per tonne for continuous-flow dryers in 1979 to a high of $5.22 per tonne for batch dryers in 1978. In spite of having a high capital investment for both years of the study, the continuous-flow systems, through higher annual use, had the lowest fixed costs of all systems, at $3.40 per tonne of corn dried in 1978 and $2.61 in 1979.

OPERATING COSTS

Total operating costs showed an increase in 1979 over 1978 for each of the three drying and storage systems for all growers in the study (Table 3). The only exception was the total for in-bin dryers using propane, for which operating costs per tonne were $5.97 in 1978 and $5.55 in 1979. These higher operating costs also represented increases when expressed as percentages.

Table 2.—A Comparison of Capital Costs for Corn Drying and Storage Using Different Drying Systems, All Growers Studied, Ontario, 1978 and 1979

	All dryers[a]		In-bin, propane		In-bin, natural gas		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	58	38	18	13	6	6	8	5	22	14
Tonnes per labor h ..	5.9	7.1	5.9	7.6	5.4	4.0	5.2	9.5	7.4	7.3
PER FARM										
Annual use, t	1338	1555	1254	1290	792	747	1023	1705	1810	2095
Corn dried, t	1041	1332	908	1192	528	699	889	1403	1499	1709
Capital invested:					dollars					
Dryer	25,623	25,627	23,243	21,544	19,121	15,712	28,730	39,800	31,574	28,606
Storage bldgs.	28,251	31,567	29,323	29,028	20,638	20,124	18,870	39,373	35,817	33,790
Total	53,874	57,194	52,566	50,572	39,759	35,836	47,600	79,173	67,391	62,396
PER TONNE										
Capital invested:										
Dryer	19.15	16.48	18.53	16.71	24.14	21.03	28.08	23.34	17.44	13.65
Storage bldgs.	21.11	19.96	23.39	22.51	26.06	26.93	18.44	23.09	19.78	16.13
Total	40.26	36.44	41.92	39.22	50.20	47.96	46.52	46.43	37.22	29.78

[a]The 1978 study included 4 low-temperature dryers; the 1979 study included none.

NOTE: Corn dried from 26.5 percent moisture to 15.5 percent in 1978, and from 30.8 percent to 15.5 percent in 1979.

Table 3.—A Comparison of Corn Drying and Storage Costs per Tonne for Different Drying Systems, All Growers Studied, Ontario, 1978 and 1979

	All dryers		In-bin, propane		In-bin, natural gas		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	58	38	18	13	6	6	8	5	22	14
STORAGE COSTS					dollars per tonne					
Fixed:										
Depreciation	1.00	.94	1.15	1.15	1.21	1.28	.85	.87	.91	.80
Int. on invest.	.97	.90	1.05	1.01	1.17	1.21	.83	1.04	.92	.74
Insurance	.08	.09	.08	.08	.13	.14	.01	.09	.09	.09
Taxes	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
Repairs & maint.	.18	.17	.21	.22	.17	.19	.16	.14	.16	.15
Total	2.25	2.12	2.51	2.48	2.70	2.84	1.87	2.16	2.10	1.80
DRYING COSTS										
Fixed:										
Depreciation	1.93	1.66	1.85	1.72	2.41	2.10	2.80	2.32	1.79	1.37
Int. on invest.	.87	.74	.84	.75	1.09	.95	1.26	1.05	.81	.61
Insurance	.07	.07	.06	.05	.11	.11	.03	.07	.08	.08
Repairs & maint.	.79	.69	.77	.74	1.00	.87	1.13	.93	.72	.55
Total	3.66	3.16	3.52	3.26	4.61	4.03	5.22	4.37	3.40	2.61
Operating:										
Fuel	3.45	4.51	4.64	4.57	1.56	2.07	3.39	4.55	3.13	4.89
Electricity	.36	.35	.44	.37	.25	.33	.19	.33	.34	.34
Labor	.67	.62	.89	.61	.74	1.00	.71	.47	.54	.61
Total	4.48	5.48	5.97	5.55	2.55	3.40	4.29	5.35	4.01	5.84
Total fx. & opr. ...	8.14	8.64	9.49	8.81	7.16	7.43	9.51	9.72	7.41	8.45
TOTAL OPERATING	4.48	5.48	5.97	5.55	2.55	3.40	4.29	5.35	4.01	5.84
TOTAL FIXED	5.91	5.28	6.03	5.74	7.31	6.87	7.09	6.53	5.50	4.41
TOTAL, ALL COSTS	10.39	10.76	12.00	11.29	9.86	10.27	11.38	11.88	9.51	10.25

NOTE: Differences in storage costs are not related to the type of drying system used.

In 1978, operating costs comprised 38 percent of total drying and storage costs for batch dryers, 42 percent for continuous-flow, and 50 percent for in-bin dryer systems with all systems using propane (Table 4). In 1979, the percentage of operating costs increased to 45 percent for batch dryers and 57 percent for continuous-flow dryer systems, while in-bin dryer systems remained at 49 percent. For the in-bin operations fueled by natural gas, operating costs as a percentage of total drying and storage costs increased from 26 percent in 1978 to 33 percent in 1979.

COMPARISON OF DRYING AND STORAGE COSTS FOR DIFFERENT DRYING SYSTEMS, GROWERS STUDIED IN BOTH YEARS

DRYING COSTS

Similar trends to those shown for all growers also were evident in data for farms studied in both 1978 and 1979. The 14 continuous-flow dryers had the highest annual use of all drying systems, handling 1459 tonnes of corn in 1978 and 1709 in 1979 (Table 5). Again, all systems showed an increase in the volume of corn dried in the second study year over the first. In average capital investment as well, these drying operations showed a pattern similar to that described in the preceding section.

FIXED COSTS

Increased amounts of corn dried in 1979 over 1978 brought about a reduction in the fixed portion of total drying costs as follows: for batch dryers, to $4.37 from $5.17 per tonne; for in-bin dryers, $3.26 from $3.48 per tonne; and for continuous-flow dryers, $2.61 from $3.17 per tonne (Table 6).

OPERATING COSTS

When operating costs on the same farms were compared for 1978 and 1979, considerable increases were observed for all drying systems. The greatest increase occurred for continuous-flow systems, which had total operating costs in 1979 of $5.84 per tonne as compared with $3.81 in 1978—an increase of 53 percent (Table 6). For batch-drying systems, the cost of $5.35 per tonne in 1979 represented a 30 percent increase over the 1978 cost of $4.12 per tonne. In-bin dryers using propane had a 28 percent increase in operating costs, at $5.55 per tonne in 1979 as compared with $4.34 in 1978. In-bin dryers fueled by natural gas had operating costs of $3.06 per tonne in 1979, a 17 percent increase over the $2.61 cost in 1978. Again, these increases were confirmed in comparisons of operating costs as a percentage of total costs per tonne (Table 7).

Table 4.—Corn Drying and Storage Costs as a Percentage of Total Costs per Tonne, for Different Drying Systems, All Growers Studied, Ontario, 1978 and 1979

	All dryers		In-bin, propane		In-bin, natural gas		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	58	38	18	13	6	6	8	5	22	14
STORAGE COSTS										
Fixed:					percent					
Depreciation	9.6	8.7	9.6	10.2	12.3	12.5	7.4	7.3	9.6	7.8
Int. on invest.	9.3	8.4	8.8	8.9	11.9	11.8	7.3	8.7	9.7	7.2
Insurance	.8	.7	.7	.7	1.3	1.4	.1	.8	.9	.9
Taxes	.2	.2	.1	.2	.2	.2	.2	.2	.2	.2
Repairs & maint.	1.8	1.6	1.7	2.0	1.7	1.8	1.4	1.2	1.7	1.4
Total	21.7	19.6	20.9	22.0	27.4	27.7	16.4	18.2	22.1	17.5
DRYING COSTS										
Fixed:										
Depreciation	18.5	15.4	15.4	15.2	24.4	20.4	24.6	19.5	18.8	13.4
Int. on invest.	8.4	6.9	7.0	6.6	11.1	9.3	11.1	8.8	8.5	6.0
Insurance	.7	.7	.5	.4	1.1	1.1	.3	.6	.8	.8
Repairs & maint.	7.6	6.4	6.4	6.6	10.1	8.5	9.9	7.8	7.6	5.3
Total	35.2	29.4	29.3	28.8	46.7	39.3	45.9	36.7	35.7	25.5
Operating:										
Fuel	33.2	41.9	38.7	40.5	15.8	20.2	29.8	38.3	32.9	47.7
Electricity	3.5	3.3	3.7	3.3	2.6	3.2	1.7	2.8	3.6	3.3
Labor	6.4	5.8	7.4	5.4	7.5	9.6	6.2	4.0	5.7	6.0
Total	43.1	51.0	49.8	49.2	25.9	33.0	37.7	45.1	42.2	57.0
Total fixed & opr.	78.3	80.4	79.1	78.0	72.6	72.3	83.6	81.8	77.9	82.5
TOTAL OPERATING	43.1	51.0	49.8	49.2	25.9	33.0	37.7	45.1	42.2	57.0
TOTAL FIXED	56.9	49.0	50.2	50.8	74.1	67.0	62.3	54.9	57.8	43.0
TOTAL, ALL COSTS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5.—A Comparison of Capital Costs for Corn Drying and Storage Using Different Drying Systems, Growers Studied in Both Years, Ontario, 1978 and 1979

	In-bin, propane		In-bin, natural gas		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	13	13	5	5	5	5	14	14
Tonnes per labor h	4.8	7.6	5.1	5.9	6.7	9.5	9.1	7.3
PER FARM								
Annual use, t	1208	1290	838	754	1444	1705	1728	2095
Corn dried, t	1023	1192	588	707	1119	1403	1459	1709
Capital invested:				dollars				
Dryer	21,544		16,446		39,800		28,606	
Storage buildings	29,028		20,889		39,373		34,647	
Total	50,572		37,335		79,173		63,253	
PER TONNE								
Capital invested:								
Dryer	17.83	16.71	19.63	21.81	27.56	23.34	16.55	13.65
Storage buildings	24.03	22.51	24.93	27.79	27.27	23.09	20.05	16.13
Total	41.86	39.22	44.56	49.60	54.83	46.43	36.60	29.78

NOTE: Corn dried from 26.5 percent moisture to 15.5 percent in 1978 and from 30.8 percent to 15.5 percent in 1979.

Higher operating costs in 1979 were mainly due to increased fuel costs (Table 6). Factors contributing to this increase were higher average moisture content in the corn crop for all growers (30.8 percent as compared with 26.5 percent in 1978), and rising prices for propane (11.4 cents per litre as compared with 10.8 cents in 1978).

Growers also reported higher electricity costs in 1979 over 1978, with the exception of those who operated continuous-flow systems; in these operations, electricity costs were the same for both years. Factors contributing to increased electricity costs were higher rates and increased use associated with the removal of greater quantities of moisture in 1979.

FUEL COSTS

Steadily increasing energy costs make fuel an important cost item in the artificial drying of corn. In 1978 and 1979, it accounted for 77 and 82 percent, respectively, of total operating costs. In 1979, propane costs for in-bin dryers were $4.57 per tonne or 52 percent of total drying costs; for batch dryers, $4.55 per tonne or 47 percent of total drying costs; and for continuous-flow dryers, $4.89 or 58 percent of total drying costs (Table 6).

For the growers studied in both 1978 and 1979, the high average moisture content of corn in the second year required each system under study to consume more propane than had been used in 1978 to dry a tonne of corn to the 15.5 percent moisture level. The estimated average beginning moisture content for corn dried through continuous-flow systems was 33 percent in 1979 and 27 percent in 1978. In 1979, it took 44 litres of propane to dry a tonne of corn, an increase of 52 percent over the 29 litres required in 1978 (Table 8). In comparison, the average batch-dryer system used 27 percent more propane fuel in 1979 (38 litres per tonne as compared with 30 litres in 1978), and the in-bin dryers used 35 percent more (38 litres of propane as compared with 28 litres in 1978).

In addition to cost increases resulting from this higher level of consumption, growers felt the impact of rising prices for propane, noted above. These data indicate that, in any attempt to lower drying costs, consideration must be given to methods of reducing fuel consumption.

There were five growers in both years who used natural gas for their drying fuel. Although the price of this fuel rose between 1978 and 1979, the cost per tonne in the latter year was only $2.00 per tonne, or 28 percent of the total drying cost (Table 6). In comparison, the fuel cost for similar in-bin systems using propane was more than double, at $4.57 per tonne. Given this price differential, natural gas might be a preferred fuel for on-farm dryers, but for the fact that it is not available to growers in all areas of the province.

LOW-TEMPERATURE DRYING

Low-temperature drying requires little or no fuel, such as propane or natural gas. It is a relatively new method for on-farm drying in Ontario.

In this study, four growers provided cost data on the system, for 1978 only. The very small sample does not permit meaningful statistical comparison with other systems; however, it does offer useful information on the economics of employing this method of drying.

Table 6.—A Comparison of Corn Drying and Storage Costs per Tonne for Different Drying Systems, Growers Studied in Both Years, Ontario, 1978 and 1979

	In-bin, propane		In-bin, natural gas		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	13	13	5	5	5	5	14	14
STORAGE COSTS				dollars per tonne				
Fixed:								
Depreciation	1.23	1.15	1.17	1.30	1.02	.87	.97	.80
Interest on investment	1.08	1.01	1.12	1.25	1.23	1.04	.90	.74
Insurance	.08	.08	.14	.15	.11	.09	.11	.09
Taxes	.03	.02	.02	.02	.02	.02	.02	.02
Repairs & maintenance	.23	.22	.16	.18	.17	.14	.18	.15
Total	2.65	2.48	2.61	2.90	2.55	2.16	2.18	1.80
DRYING COSTS								
Fixed:								
Depreciation	1.84	1.72	1.96	2.18	2.74	2.32	1.66	1.37
Interest on investment	.80	.75	.88	.98	1.24	1.05	.74	.61
Insurance	.05	.05	.11	.12	.09	.07	.10	.08
Repairs & maintenance	.79	.74	.82	.91	1.10	.93	.67	.55
Total	3.48	3.26	3.77	4.19	5.17	4.37	3.17	2.61
Operating:								
Fuel	3.18	4.57	1.60	2.00	3.30	4.55	3.02	4.89
Electricity	.32	.37	.23	.29	.25	.33	.34	.34
Labor	.84	.61	.78	.77	.57	.47	.45	.61
Total	4.34	5.55	2.61	3.06	4.12	5.35	3.81	5.84
Total fixed & operating	7.82	8.81	6.38	7.25	9.29	9.72	6.98	8.45
TOTAL OPERATING	4.34	5.55	2.61	3.06	4.12	5.35	3.81	5.84
TOTAL FIXED	6.13	5.74	6.38	7.09	7.72	6.53	5.35	4.41
TOTAL, ALL COSTS	10.47	11.29	8.99	10.15	11.84	11.88	9.16	10.25

NOTE: Differences in storage costs are not related to the type of drying system used.

Table 7.—Corn Drying and Storage Costs as a Percentage of Total Costs per Tonne, for Different Drying Systems, Growers Studied in Both Years, Ontario, 1978 and 1979

	In-bin, propane		In-bin, natural gas		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	13	13	5	5	5	5	14	14
STORAGE COSTS								
Fixed:				percent				
Depreciation	11.7	10.2	13.0	12.8	8.6	7.3	10.6	7.8
Interest on investment	10.3	8.9	12.5	12.3	10.4	8.8	9.8	7.2
Insurance	.8	.7	1.5	1.5	.9	.8	1.2	.9
Taxes	.3	.3	.2	.2	.2	.2	.2	.2
Repairs & maintenance	2.2	1.9	1.8	1.8	1.4	1.1	2.0	1.5
Total	25.3	22.0	29.0	28.6	21.5	18.2	23.8	17.6
DRYING COSTS								
Fixed:								
Depreciation	17.6	15.2	21.8	21.4	23.1	19.5	18.1	13.3
Interest on investment	7.6	6.6	9.8	9.7	10.5	8.8	8.1	5.9
Insurance	.5	.4	1.2	1.2	.8	.6	1.1	.8
Repairs & maintenance	7.5	6.6	9.1	9.0	9.3	7.8	7.3	5.4
Total	33.2	28.8	41.9	41.3	43.7	36.7	34.6	25.4
Operating:								
Fuel	30.4	40.5	17.8	19.7	27.9	38.3	33.0	47.7
Electricity	3.1	3.3	2.6	2.8	2.1	2.8	3.7	3.3
Labor	8.0	5.4	8.7	7.6	4.8	4.0	4.9	6.0
Total	41.5	49.2	29.1	30.1	34.8	45.1	41.6	57.0
Total fixed & operating	74.7	78.0	71.0	71.4	78.5	81.8	76.2	82.4
TOTAL OPERATING	41.5	49.2	29.1	30.1	34.8	45.1	41.6	57.0
TOTAL FIXED	58.5	50.8	70.9	69.9	65.2	54.9	58.4	43.0
TOTAL, ALL COSTS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 8.—Propane Use and Costs for Different Corn Drying Systems, Growers Studied in Both Years, Ontario, 1978 and 1979

	All growers		In-bin, propane		Batch, propane		Continuous flow, propane	
	1978	1979	1978	1979	1978	1979	1978	1979
No. of systems	32	32	13	13	5	5	14	14
Per labor hour:								
Tonnes dried	6.7	7.6	4.8	7.6	6.7	9.5	9.1	7.3
Bushels dried	264	301	189	299	264	374	358	287
Average beginning moisture, %	26.5	30.8	27.5	30.0	26.0	29.5	27.0	33.0
Points of moisture removed,[a] %	11.0	15.3	12.0	14.5	10.5	14.0	12.5	17.5
PROPANE								
Used:								
Litres per tonne	29	41	28	38	30	38	29	44
Gallons per bushel	.16	.23	.16	.22	.17	.21	.16	.25
Bushels per gallon	6.2	4.3	6.3	4.6	6.0	4.7	6.2	4.0
Cost:								
¢ per litre	10.8	11.4	11.2	11.9	11.0	11.8	10.5	11.1
¢ per gallon	49.1	51.8	50.8	54.0	50.0	53.9	47.7	50.1

[a] It was assumed that all corn was dried to 15.5 percent moisture.

The average drying cost for the four systems studied in 1978 was $4.55 per tonne. No propane or natural gas was used for drying; but electricity costs were higher than those for other systems, at $1.91 per tonne as compared with $0.36 per tonne for the average of all growers in 1978 and $0.35 in 1979 (Table 3). More details on low-temperature drying costs are provided in the report referred to earlier.[1]

Although all types of drying systems require good management techniques, the operation of low-temperature systems requires top management practices. The slowly drying corn must be checked often to ensure that it does not spoil. In addition, the field moisture content should be 25 percent or less to permit proper drying.

On balance, it appears that low-temperature drying does have a place in Ontario corn production. The increasing costs of fuel may lead more growers to use this system, or at least some aspect of it, for their on-farm drying operations.

COMPARISON OF ON-FARM AND COMMERCIAL DRYING COSTS

The drying charges for corn at 30.8 percent moisture (the average beginning moisture level for all farms studied in 1979), published by the Ontario Grain and Feed Dealers' Association for September 1, 1980, was $10.90 per tonne using natural gas and $13.10 per tonne using propane. In comparison, costs reported by growers in this study for 1979 were $7.43 per tonne for in-bin systems using natural gas; and $8.81, $9.72, and $8.45 for propane-fueled in-bin, batch, and continuous-flow systems respectively (Table 3). The respective percentage differences for propane users between on-farm and commercial rates were 49 percent, 35 percent, and 55 percent. From the data obtained in this study, it appears that the average drying costs for on-farm systems using either propane or natural gas were lower than the rates charged by commercial elevators.

STORAGE COSTS

During the two-year study, average on-farm storage costs for all storage systems amounted to $2.25 per tonne in 1978 and $2.12 in 1979 (Table 3). The average volume of corn and other grains stored increased to 1555 tonnes in 1979 from 1338 tonnes in 1978 (Table 2).

Depreciation and interest on investment combined, at $1.97 per tonne in 1978 and $1.84 in 1979, made up 88 and 87 percent respectively of total on-farm storage costs (Table 3). The remaining 12 and 13 percent ($0.38 per tonne in 1978 and $0.28 in 1979) consisted of charges for insurance, taxes, and repairs and maintenance.

COMPARISON OF ON-FARM AND COMMERCIAL STORAGE COSTS

During the 1978-79 and 1979-80 crop years, most commercial elevators in Ontario charged a rate of $0.80 per tonne per month for storing corn, plus a $1.20 per tonne elevation charge at delivery time. These charges

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[1] Fisher, *op. cit.*

Table 9.—Interest Costs of Holding Corn in Storage, per Tonne, per Month at Varying Interest Rates and Corn Values

Value per tonne	Annual interest rate, %			
	14	16	18	20
	dollars per tonne per month			
$ 98.42	1.15	1.31	1.48	1.64
$118.10	1.38	1.57	1.77	1.97
$137.79	1.61	1.83	2.07	2.30
$157.47	1.84	2.09	2.36	2.63
$177.16	2.07	2.36	2.66	2.96

are applied to corn with a moisture content of 15.5 percent. For growers in this study, the average annual on-farm storage rate was $2.25 per tonne in 1978 and $2.12 per tonne in 1979 (Table 3). These costs are equal to about three months of commercial storage at $0.80 per tonne per month.

Evidently, it costs money to store corn either at the farm or at the country elevator. At both locations, drying, handling, and transportation costs must be added to the actual cost of storage. Another important cost is interest on the stored corn.

INTEREST COSTS OF HOLDING CORN IN STORAGE

Interest costs can be an expense of storage in two ways. One way is related to the continuation of loans arranged by the grower to finance his operations. By storing corn instead of selling it at harvest, the grower loses the opportunity to repay all or part of his operating loans and thereby reduce the total interest costs. The second interest cost is related to the lost investment opportunity that results from deferred sale of the crop. A grower who sells his corn instead of storing it can invest the proceeds and earn interest on the investment.

Interest costs on stored corn add up quickly, and they should be taken into account when future prices are evaluated. If a tonne of corn worth $118.10 were put into storage, the interest cost at a rate of 18 percent per annum would be $1.77 per tonne per month (Table 9). (For a bushel of corn at $3.00, the interest cost would be $0.045 per month.) This means that the price of corn must rise by a minimum of $1.77 per tonne per month just to cover the interest cost.

OTHER COST CONSIDERATIONS

In addition to interest on the value of the stored corn, the grower should be aware of the cost of invisible loss. Shrinkage and invisible loss occur when corn is handled and put into storage. In commercial operations, this loss is estimated to be one-half of 1 percent of the weight of the corn. In the wet shelled corn conversion tables used by commercial elevators, the allowance of one-half of 1 percent for invisible loss is calculated into the conversion numbers.

Another potential cost arises from loss of quality during storage. The grower who stores his corn in on-farm facilities is responsible for maintaining quality. The crop can deteriorate (and it quite often does) through improper drying, handling, and aeration.

If a farmer decides to store his corn at the farm, the variable costs (interest on the value of the stored corn, the amount of the invisible loss, and possible quality loss) are more important to his final decision than are the annual fixed costs of owning the storage facilities. The fixed costs, while important, can be overlooked in any given year when a farmer makes a decision to store corn in existing on-farm storage facilities. If the storage facility already exists, the annual fixed costs of ownership must be paid, whether or not any grain is stored in it. Over a number of years, the seasonal price increase for corn or other storable grains must cover the fixed costs if the initial investment is to prove profitable.

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